ART INTERNATIONAL

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Volume XIII/2 *Thirteenth Year of Publication* February 20, 1969

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COVER: Our cover this month is by the young French painter ROBERT MALAVAL, who is represented in the travelling exhibition, "European Painting Today" (currently at The Jewish Museum in New York), and whose work is regularly exhibited at the Galerie Yvon Lambert in Paris.

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ASSISTANT TO PUBLISHER: Vera Haller.

SUBSCRIPTIONS: A one-year subscription (10 numbers) costs $15.00 or 63 Swiss francs; a three-year subscription costs $36.00 or 159 Swiss francs. For airmail subscription to the United States add $20.00 postage per annum. Lifetime subscriptions: $250.00. Subscriptions may be obtained by writing to the address above and may be paid for by cheque or money order. They may also be obtained through all better bookshops, including George Wittenborn, 1018 Madison Avenue, New York; Alec Tiranti, 72 Charlotte Street, London; Blackwell's, Oxford; La Hune, 170, boulevard Saint-Germain, Paris; Plüss, and Kurt Stäheli, Zurich; Herbert Lang, Berne; and the Galleria del Naviglio, Milan.

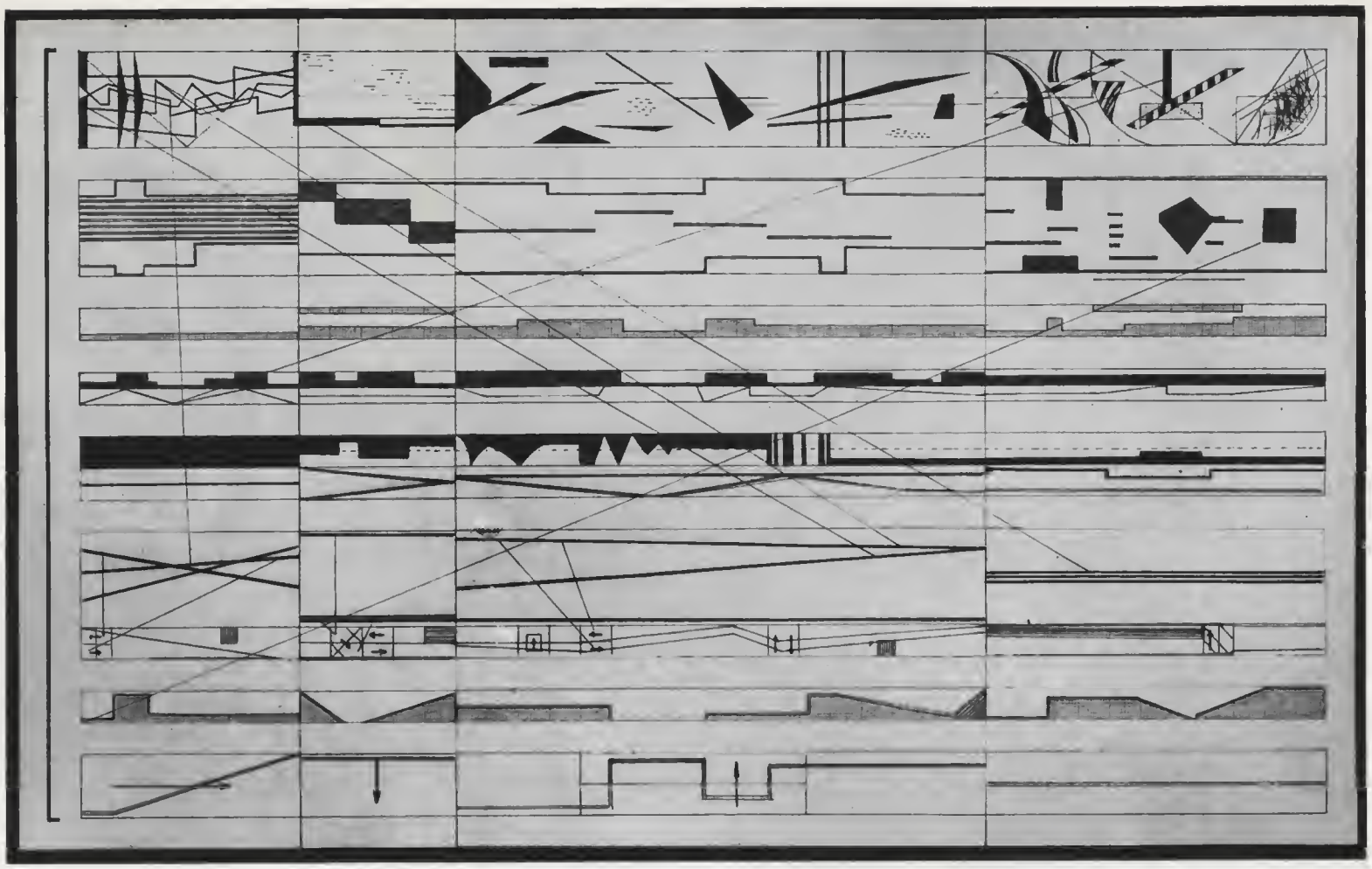
SINGLE COPIES: $1.50 / Swiss frs. 6.45 / French frs. 7.50 / Lire 900.

ADVERTISING: Should be received by the 10th of the month preceding publication. In France advertising should be ordered through Marcel Ullmo, 70, boulevard Flandran, Paris-16e, PASsy 03–58; Marcelle Brunswig, 18, rue Saussier-Leroy, Paris-17e, Tel. WAG. 79–29; Jacqueline Heusch, 7, rue Cognacq-Jay, Paris-7e, Tel. 468–63.99; Lebrun-Sermadiras, 17, rue Ernest-Renan, Paris-15e, Tel. 306–30–70. In England our advertising representative is J. Arthur Cook, 9 Lloyd Square, London W.C. 1; in Rome, Topazia Alliata, Piazza San Calisto 9.

OWNERSHIP: ART INTERNATIONAL is owned, edited and published by James Fitzsimmons at Via Maraini 17-A, Lugano, Switzerland. There are no stockholders.

Printed by Buchdruckerei Berichthaus, Zwingliplatz 3, Zurich, Switzerland

Second-class postage paid at Zurich and New York, N.Y.



Visual score by Peter Zinovieff. From the exhibition "Cybernetic Serendipity", by courtesy of the I.C.A., London

ART IN THE ELECTRIC AGE

JOHN CHANDLER

Three current exhibitions amplify the trend in art toward involvement and correspondence with electronic technology. The first was *Cybernetic Serendipity*, which opened simultaneously with the new facilities of London's Institute of Contemporary Arts. Selected and directed by Jasia Reichardt who spent two years visiting many countries and talked to many scientists and artists, it is an international exhibition of contemporary works which, in varying degrees, are either dependent upon the computer for their generation or else are works of art which themselves are cybernetic devices or automata and thereby function as computers or feedback devices. As Miss Reichardt wrote in her introduction to the special issue of *Studio International* which served as the catalogue of this exhibition: "'Cybernetic Serendipity' deals with possibilities rather than achievements, and in this sense is prematurely optimistic."

Pontus Hultén's show now at the Museum of Modern Art in New York is titled *The Machine at the End of the Mechanical Age*, which may sound prematurely pessimistic, and deals more with achievements than with possibilities, taking an historical approach and including works from Leonardo to La Monte Young. This exhibition successfully presents a history of artists' fascination with machines, ranging from the optimistic to the pessimistic and from the deadly serious to the lively playful. Because of this historical approach Hultén's machines were largely wheels, gears, pistons and rods, whereas Reichardt's were made of circuits, switches, diodes and transistors. Hultén's exhibition included a dozen or so recent works which belong to the latter category, including nine works selected from 150 entries to a prize contest sponsored by Experiments in Art and Technology (EAT), an organization established to encourage fruitful collaboration between artists and engineers. The works which did not make the MOMA show are exhibited at the Brooklyn Museum in a show titled *Some New Beginnings*. This third show is very different from the other two in being hastily thrown together, badly installed, fifty percent nonfunctioning and entirely unselective. Whether or not it was intentional, the total effect of the Brooklyn show is that of the uncaged McLuhanesque mosaic in which the spectator is bombarded with a chaos and cacophony of unrelated images of sight and sound haphazardly and accidentally juxtaposed. Sensitive mechanisms, whether human or artificial, programmed to respond to sounds, blow their fuses when confronted with this kilowatt carnival.

The young science of Cybernetics is the outgrowth of the conviction shared by Norbert Wiener, Arturo Rosenblueth and others that the "most fruitful areas for the growth of the sciences were those which had been neglected as a no-man's land between the various established fields". Cybernetics is the result of collaboration between physicians, physiologists, physicists, mathematicians, communications engineers, logicians, linguists, sociologists, anthropologists, and psychiatrists, and its output is as universal as its input. The collaboration between cybernetics and art seems then to have a high potential for both.

Game-playing computers have demonstrated that machines can think ahead and solve difficult problems, as found for example in checkers or chess. Machines can learn from experience and avoid making the same mistake twice. They can locate problems and make happy guesses for their solution. The software men involved with computers call this aspect of them "heuristic", but Jasia Reichardt used the word "serendipity"—the faculty of making happy chance discoveries. The process by which this faculty operates usually starts by following incomplete programmed orders and then fills in the rest by chance (should we call it intuition?). This is called the "stochastic" process, and the results are not altogether unlike the activity we call creative. However, few are willing to say that these machines are creative, and most of those closest involved deny it. Many share Wiener's belief that machines should never be allowed to make final important decisions on their own. Though electronic composer Peter Zinovieff wrote that "a product composed by a machine, realized and automatically edited by another, should perhaps be judged by a third", most still affirm that man remains the measure of whether whatever the machine has made is valuable or not.

That machines *can* think is by now a widely accepted fact, but how they think is generally not as well known. The word "computer" indicates machines that do computation and whose thought is mathematical. Logical thought can easily be reduced to integers, and Boolean algebraic logic reduces mental processes and propositions to either-or, yes-no, on-off alternatives similar to binary mathematics. The switch is either on or off; the memory cell is either charged or not in the machine. Moreover, the human nervous system operates on a similar on-off binary mode. Cybernetic devices can operate with artificial sense organs and proprioceptors, sources of information from the outside world. This information can be processed, stored in memory cells and recalled at will to bring about changes in the environment or in itself by channelling the output as new input. The sense organs by which the impressions are received are photoelectric cells or other light receptors, radar systems, hydrogen-ion-potential recorders, pressure gauges, microphones, etc. which substitute for seeing, hearing, testing, feeling and other functions of the sense organs. The output may operate effectors of diverse sorts such as TV screens, electric motors, sound generators, even crayons and typewriters. "The automata of the present age are coupled to the outside world both for the reception of impressions and for the performance of actions. They contain sense organs, effectors, and the equivalent of the nervous system to integrate the transfer of information from the one to the other. They lend themselves very well to description in physiological terms."[1] Whether or not the life versus art controversy is real, it appears that Wiener was quite right to assign the old vitalism-mechanism controversy to the limbo of badly posed questions.

Not only has the practical hardware and software of cybernetics influenced art, but also the theory of cybernetics, generally called information theory, appears to have direct appli-

Picabia. *Girl Born without Mother*, ca. 1917. Gouache on railway machine diagram, $19\frac{5}{8} \times 25\frac{1}{2}''$
Collection: Mr. and Mrs. Arthur A. Cohen, New York. By courtesy of The Museum of Modern Art

cation to the field of aesthetics. Aware that practising artists rarely find applications of aesthetic theory in their everyday work, I have bowed to their prejudice and have divided the following article into two parts, either of which may be read without the other. However, since most theories of aesthetics have little value to the artist because they are based on past principles which present artists have surpassed, or at least lost interest in, the present theory being concerned, as is information theory, with probabilities and predictions, is based on principles of art not yet altogether realized by artists, which therefore might even prove to be entertaining to them.

PART ONE: ART AND ARTIFICIAL INTELLIGENCE

The word cybernetics was coined by Wiener in 1947 from the Greek *Κυβερνητης*, meaning "steersman" or the pilot of a ship. Cybernetics is defined as the control and communication in the animal and in the machine. "Control" here means the regulation and direction that is given to humans or machines by servomechanisms, or feedback devices. An early form of servomechanism is the governor on a steam-powered machine. The word governor is itself derived from the Latin corruption of the Greek *Κυβερνητης*. A governor was usually constructed of two balls on pendulums attached to a revolving rod (a governor is the central image in Picabia's *Girl Born Without a Mother*, 1917). It worked in such a way that as the rod revolved faster or slower the balls would raise or lower, opening or closing a valve which would regulate the force of steam and the speed of the machine. A thermostat is also a feedback device which takes information from the environment and translates it into action by either turning on or off the furnace to regulate the temperature in the room. The modern digital computer is essentially a feedback device as is the human nervous system, which allows us to pick up a pencil without overshooting the mark and light a cigarette without burning our eyelashes.

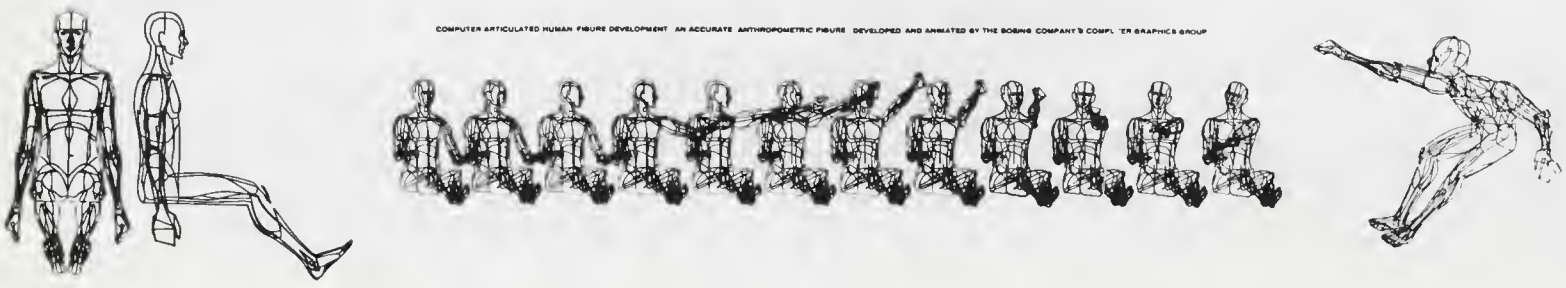
It is clear then that cybernetics is related to art not only in art produced by computers but in any art which in any way responds to stimulus, processes and perhaps stores gathered information, and responds to the stimulus with appropriate action. Apart from music (and some poetry of questionable merit) there is yet relatively little art produced by or with the aid of computers, but there is an increasing number of works of art of the second category.

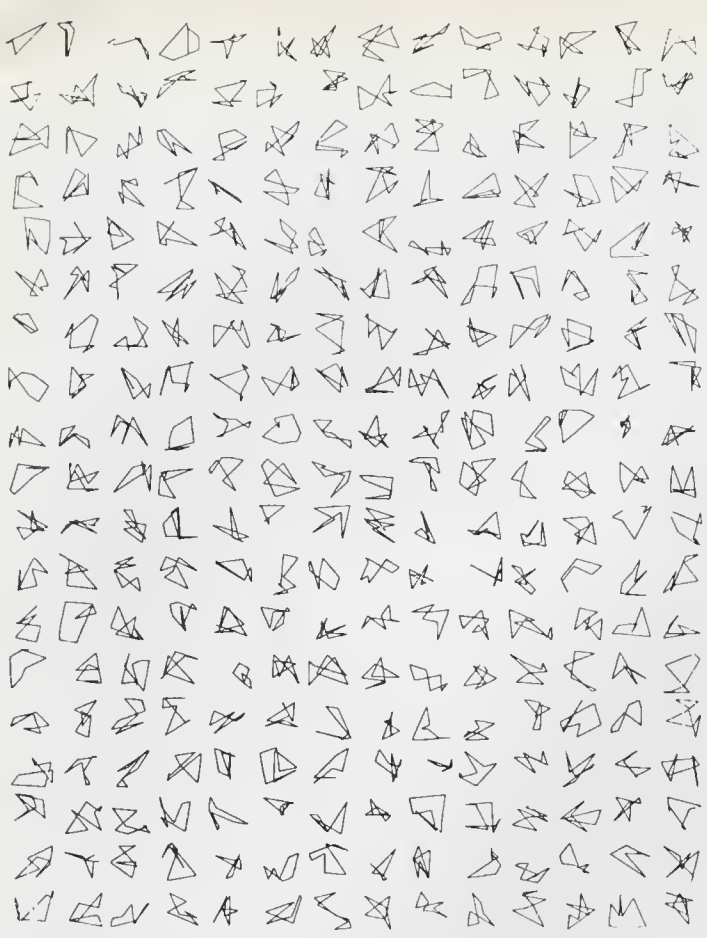
Art produced with computers includes computer graphics in which the output of the computer is connected to a pen or other drawing or picture-making implements and apparatus and produces patterns, outline drawings, or mosaics of signs and symbols varying in tone from white to black like the picture on a TV screen. Most of these computer-generated graphics have been produced not by artists but by scientists, either for practical purposes, as by Boeing Aircraft or General Motors for use in the design of planes and cars, or for the fun of it. The illustration was made by Boeing's computer graphic group for determining the best locations for the apparatus on the instrument panel of an aircraft. Of those computer graphics made just for the fun of it, the most interesting are those in which the machine has been "given its head" after some limitations have been set within which it can work. *8 Corner*, by George Nees was the result of telling the machine to "distribute eight dots inside the figure-square and connect them with a closed straight-edged line". *Boxes* is by IBM 1620 and IBM 1627 Plotter under the guidance of Darel Eschbach of the University of Toledo. Here the corners of each rectangle were randomly selected by the computer "who" was then directed to make the size of each box so that the x dimension was 1.09 times the x coordinate. The ensuing design has squares on the diagonal and rectangles on each side as you move away from the diagonal. However, even the best of these computer graphics are of questionable value as art and most of them are far too derivative or imitative of bad artistic models or else too illustrative of mathematical or scientific formulae. Though I know of no sculpture thus far computer generated, it is equally possible. The output of the computer need simply be attached to such things as metal-fabricating machines, lathes, or whatever.

Art of the other category, which responds to and influences its surroundings has at this time produced works less derivative than computer-generated art and tends to be more the work of artists collaborating with engineers than of Sunday-painter scientists. Art of this category belongs more to the tradition of automata than sculpture, though it is certainly not without its antecedents in art. Whereas the automata of the seventeenth and early eighteenth century were modeled after clockworks, and the automata of the late eighteenth and nineteenth centuries were modeled after the steam engine, the present automata, "whether in the metal or in the flesh, is a branch of communication engineering, and its cardinal notions are those of message, 'noise' . . . quantity of information, coding technique, and so on".[2] Art of previous ages tended to be precise and balanced, with the parts interrelated and intermeshed like the gears of a clock. It was impressed with power, high-level energy, force; for every action there was an equal and opposite reaction. In both ages it was highly individualistic, though centralized in the art capitals and their successive styles and movements. It was private, portable and marketable. It could hang on the wall or decorate the garden of anyone who could afford it. The art of the electric age has a tendency to be the result of collaboration, not the collaboration of the master/apprentice workshops of the Renaissance, but the collaboration of equals, each a master of special skills indispensable to the production of the art object. And although the art market has perhaps never been better, there are signs of a new art that will be highly public and accessible to all as a normal part of our daily lives. This art will be more commodious. It will be less individualistic and more personal; more of a carrier than something carried or portable; less concerned with "lasting qualities", endurance, appreciation and depreciation, and more transitory and temporary, designed for this particular place at this particular time, come what may. And the idea of art centers may give way to an art as decentralized as education (as much as Boston likes to think of itself as an educational center, it has to admit the existence of Berkeleys, Chicagos, New Havens). The universities, with industrial and government aid, may become the patrons of the new art as they are of the new science.

Of course, the roots of the cybernetic art are in the kinetic works of a few decades ago. Some of these, like Moholy-Nagy's *Light-Space Modulator* (1921–1930) were conceived not so much as things to be looked at as things which interact with their surrounding in such a way that the art is largely in what the object does to it, in this case with space and light. Most mechanical-kinetic art, however, was self-contained,

Computer articulated human figure development: an accurate anthropometric figure developed and animated by the Boeing Company's Computer Graphics Group. By courtesy of the I.C.A., London



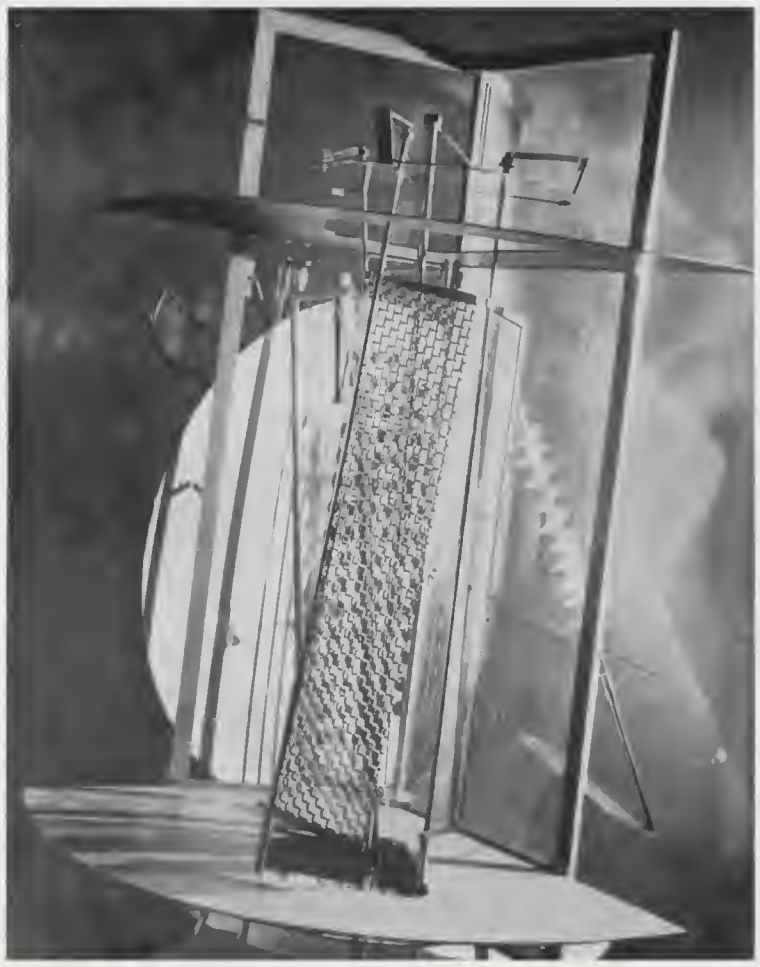


George Nees. *8-corner*. Problem: distribute eight dots inside the figure-square and connect them with a closed straight-edge line. By courtesy of the I.C.A.

Darel Eschbach (University of Toledo, Ohio). *Boxes*. A design made on an IBM 1620 with an IBM 1627 plotter and programmed in Fortran

and though, like all art, such art works may affect the surrounding space of the rooms in which they are contained, they still remain somewhat set apart and self-contained. Alexander Calder's *A Universe* (1934), a motorized sculpture in which a small electric motor rotated arms which alternately pulled or relaxed the tension on strings which raised and lowered the spheres along their predetermined paths, is a self-contained universe. One of the works in the Brooklyn show resembled it. *Orbiter* by Arthur Hoener is also concerned with the dual motion of interrelated orbs; the smaller orb disappears into the larger one and then reappears as they both revolve on their axes. In both there is motion without change; the objects move on their serpentine paths unstimulated and unresponsive to whatever is going on around them, oblivious till oblivion. These remarks are in no way meant to detract from their success as art; they are both quite beautiful objects and have an almost hypnotic effect on the viewer. But they are not yet cybernetic. The difference between the earlier attitude toward kinetic sculpture and the newer attitude may best be examined in two more works from the Machine show: Naum Gabo's *Kinetic Sculpture: Standing Wave* (1920) and Wen Ying Tsai's *Cybernetic Sculpture* (1968) (a 1966 edition of which is in the Cybernetic Serendipity show).

Moholy Nagy. *Light-Space Modulator*, 1922–30. Steel, plastics and wood mobile construction; height including base 59½″. Collection: Busch-Reisinger Museum, Harvard University, Cambridge. By courtesy of The Museum of Modern Art



Calder. *A Universe*, 1934. Motorized mobile with iron pipe, wire, string and wood; height 40½″. Collection: The Museum of Modern Art (Gift of Abby Aldrich Rockefeller)

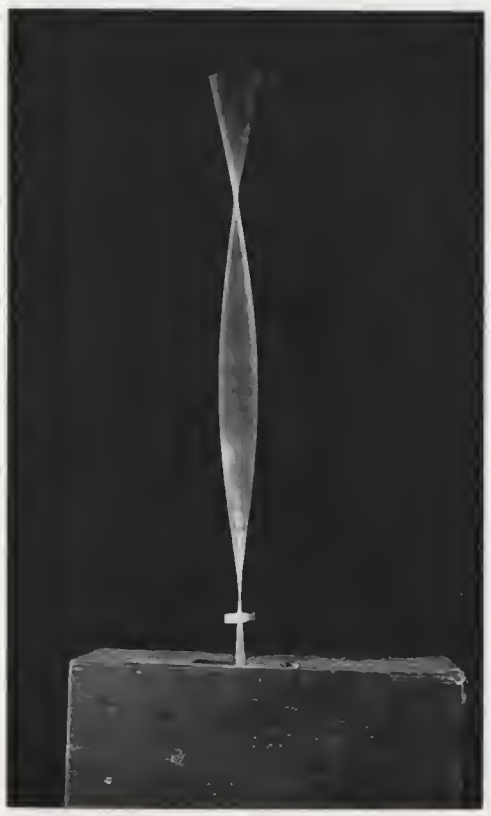
Arthur Hoener. *Orbiter*

Wen Ying Tsai. *Cybernetic sculpture No. 15*, 1968. Stainless steel and cement, $43 \times 23\frac{1}{2} \times 14\frac{1}{2}''$. Collection: Robert Mayer, Chicago. By courtesy of the I.C.A.

Both Gabo's and Wen's work rapidly oscillate metal rods and create patterns of harmonic motion, but whereas Gabo's is in open, continuous light and the viewer can see the entire modulations, Wen's motions are revealed by stroboscopic lights periodically flashing so that the viewer can see only those parts of the motion illuminated. This in itself would not make the work of Wen cybernetic. Sound receptors are added which control the flashing of the lights. If the viewer speaks or claps his hands the patterns immediately change, making the sculpture responsive to the environment and the people in it. (Unfortunately, the part of the exhibition where Wen's piece was installed sounded, because of other works in the vicinity, like an iron-lung factory during a change of shifts; this noise overwhelmed the noise of all but the most noisy spectators and kept the image constant, in tune with the surrounding din.)

Other responsive works ranged from the quite simple $\pm \sqrt{\text{Rondo Electronique}}$ of Nam June Paik, a color TV screen which modulates ribbons of primary colors as the spectator moves a magnetic wand before it, to Lillian Schwartz's *The Proxima Centauri*, a box which exposes a plastic balloon on which are projected psychedelic jelly-like images as long as the spectator doesn't pay too much attention to it, but blushes and withdraws if the spectator draws near to have a better look. The version at the Machine show was so crowded, the sphere lay continually cowed deep in its cave, though the

Gabo. *Kinetic Sculpture; Standing Wave*. Original 1920, Tate Gallery, London; reconstruction by Wit Wittnebert, 1968. Metal rod with electrical vibrator; height with base $24\frac{1}{4}''$. By courtesy of The Museum of Modern Art



Wen Ying Tsai (artist and engineer) and Frank T. Turner (engineer). *Cybernetic Sculpture*, 1968. Multiple stainless steel units, each 9′ 4″ high, with oscillator, stroboscopic lights and other electronic equipment. Collection: Howard Wise Gallery, New York. By courtesy of The Museum of Modern Art

version of the same piece at the sparsely populated Brooklyn show performed rather well.

I have neglected to mention the collaborating engineers, which is perhaps just, since it was they who won the cash prizes and not the artists. Frank Turner worked with Wen, who is himself an electrical engineer. Miss Schwartz's collaborator was Per Björn. The engineers who won the first prize were Ralph Martel and Harris Hyman who, with Jean Dupuy, produced *Heart Beats Dust.* This fascinating piece was a box of plywood with a glass face and contained a red dust which mostly lay dormant when not in operation. Some of the dust particles swirled about in a cone of high intensity light projected from the top of the box. Beneath the dust was a speaker which was attached to a stethoscope some distance away. When the stethoscope was placed on someone's heart, his heartbeat would be greatly amplified and cause the speaker to vibrate in rhythmic bursts; this in turn sent explosions of the red dust high into the chamber like blood from a severed artery; the dust would then return to the floor of the box pulled by gravity, looking very much like red snow. I had never realized with what varying rhythms peoples' hearts beat. The effect of all this was a perfect blending of the human and the machine. The basic elements of this work were light, sound, and dust (a further example of the trend Lucy Lippard and I wrote about in our article, "The Dematerialization of Art") motorized by one of the oldest machines known to man—his heart.

A collaboration of visual designer Marian Zazeela and electronic composer La Monte Young called *Title to be Determined* (1967–68) in the machine show is an example of that hopefully short-lived trend to affront the spectator as well as confront him. Like a work in the Brooklyn show which flashes high wattage floodlights at the viewer which can hurt his eyes and burn his skin (ironically titled, *I Am A HUMAN BEING, Do Not Destroy* by its maker, Jean Toche), Young's monotonous electronic music is designed to hurt the listener's ears. Originally designed to send its beams of sound into the room in such a way that one walking through the room would sometimes walk out of its path and not hear it and at other times walk into it and actually feel it, Hultén had the thoughtfulness to put a muzzle on it for this exhibition and anyone who wanted, out of masochism, could hear it by placing earphones on his head. I suppose there is a place for this sado-masochist art, but I think its place is in a brothel rather than a museum, especially this box with its pale pink and green doilies.

A group of artists and engineers associated with Yale University who call themselves Pulsa made a pilgrimage to the MIT office of a famous physiologist who has been intimately involved with cybernetics since its inception. He gave them an audience and they found his conversation highly exciting, but when they invited him to come to the Boston Public Gardens where their latest work was installed, he replied, "All collaborations between art and technology I have seen have either been bad art or bad technology or both. I would rather remember you in connection with this pleasant afternoon of conversation rather than see your work and ruin this favorable impression." For the most part, I am in sympathy with the cybernetic ist's judgment. However, I feel that had he gone to the Public Gardens that night, he would have had to modify it somewhat as I did mine. Pulsa's experimental art was the most highly successful collaboration of science and art I have yet seen. It was installed in and around the four-acre pond early in October 1968, ran from October 8 to 27, and then was dismantled and removed. It is no more. In fact it wasn't the same from one night to the next since it was programmed differently each night. It was as though a symphony came to town, performed several pieces each night for twenty nights without repetition, and moved on; yet, unlike a symphony, it cannot set up in another city and perform the same pieces, for part of its ingredients were the ambient lights and noises of the Boston Public Gardens at the specific hours of the performances.

One need not have known how it worked to have enjoyed it, but for the mechanically minded (and according to cybernetics we all are) a mechanical description is not out of place. Fifty-five xenon strobe lights were placed underwater, more or less in a concentric circle arrangement. The pond is dumbbell shaped, with a walk bridge across the narrows and a small island near the middle of one end. The lights were arranged somewhat in accordance with the shape of the pond. When a pebble is dropped in water it sends out concentric waves and this too probably influenced the arrangement of the lights. Around the perimeter of the pond were placed fifty-five poly-planar speakers, above the water level a few inches. These lights and speakers were the output devices or effectors. What they did was determined by the programme received by the input devices which included elements of analogue and digital computers, a punch-paper tape reader, a signal synthesizer, and magnetic tape. Light directed at the paper tape would either be read or not by photoelectric cells. If there was a punched hole in a certain location the light would register, the switch turned on and the electrical impulse was released; if there was no hole at that location, there was no corresponding action. This is the essential "yes-no" binary mode of a computer's operation. Each strobe and each speaker has specific locations on the roll of tape, so that they would flash, sound off or not as programmed. For each light there seemed to be a corresponding sound so that the combined effect was both light art and electronic music.

Sometimes the light flashes would echo from one end of the pond to the other, running the length of the pond in seconds to the accompaniment of sounds like chirping and croaking frogs. Sometimes the sounds evoked crickets and grasshoppers, while the lights seemed to figure skate under the bridge and around the island, doing figure-eights. At other times the sounds were like memorial taps with nonsyn-

Per Björn (engineer) and Lillian Schwartz (artist). *The Proxima Centauri.* At approach of spectator the illumined globe descends into base, rising when left alone

Nam June Paik. ± √*Rondo Electronique*, 1966–68. Collection: Howard Wise Gallery, New York. By courtesy of The Museum of Modern Art

Jean Dupuy (artist), Ralph Martel and Harris Hyman (engineers). *Heart Beats Dust*, 1968. Height 84". Collection of the artist and engineers. By courtesy of The Museum of Modern Art

chronous echoes across the pond. Sometimes the lights seemed to flash at random while brass bands played different tunes as in a parade. All the while lights from surrounding hotels and restaurants added their reflections to the pond while headlights and taillights, horns and sirens added their momentary contributions and went their ways. The effect would also change considerably as one walked around the paths that encircle the pond. A particularly exciting effect could be discovered from the walk below the bridge. Balls of light like hazy fireballs would dash back and forth before your eyes like the ball in a tennis match.

The Pulsa performance was a successful blend of electronics and nature in an urban environment. Completely unostentatious, it was simply there to be enjoyed by those who happened to be passing by on their normal everyday routines. Many stopped briefly, some not at all, while some returned night after night and sat on the banks in meditation. Only the ducks seemed not to notice it at all. It was a truly public art, easily accessible to all and it probably created longings among those who encountered it for a more responsive urban environment. The Pulsa group has said that "public art must treat all parameters of the urban and technological environment as potential media for artistic expression in order to introduce these concepts on a large scale into the cities of the future". They want to work with the men who shape the urban environment.

Their Boston experiment was subsidized by universities, industries and local government and was done in cooperation with Signs/Lights Boston, consultants to the Boston Redevelopment Authority and experimenters in new uses of light in the city. Some of the funds came from an urban beautification demonstration grant from the US Department of Housing and Urban Development. I mention all this because I think here is an excellent example of how public and private sectors of the community can cooperate and collaborate with artists with the aim of making the whole future environment a work of art.

The seven young men who are Pulsa, Michael Cain, Patrick Clancy, William Crosby, William Duesing, Paul Fuge, Peter Kindlmann and David Rumsey, are a softspoken group, so modest that you wouldn't know they were artists. They see themselves as researchers and experimenters, and their works not as finished works of art but as proposals and demonstrations, constantly being altered and improved, which suggest directions that future environments might take—if anyone cares.

The old opposition between the sciences and the humanities, C. P. Snow's two cultures, has dissolved. The collaborative works are indeed "some new beginnings", and richer in potentialities than accomplishment. Electronic art could, like Futurism, be but a passing parenthesis in the history of art, but I think not. It could, like film and TV, eschew art for mass entertainment; it has the potential for circuses and a lot of it now belongs in penny arcades (and probably even more will in the future). But used as a tool in the hands of an artist it will also produce art.

Cybernetic Serendipity will open in Washington, DC at the Smithsonian and will then move to the Jewish Museum in New York from March 29 to May 18. From there it will visit nearly every major city in the US, travelling for two years. *The Machine at the End of the Mechanical Age* will travel to Houston and then to San Francisco. The catalogue of the Machine show, written by Pontus Hultén, is excellent and demonstrates his universal knowledge. The introductory essay is a fine example of intellectual history with a focus on the interrelations of art and technology.

PART TWO: FORM AND INFORMATION THEORY: NEW MEANINGS OF MEANING IN ART

Since cybernetics is largely a branch of communications engineering and as such is concerned with the flow of information and messages, it occurred to me that its study by an aesthetician might throw new light on some problems of aesthetics, especially the problem of meaning in the visual arts. The following are meant only as tentative suggestions by one who as yet is only half immersed in information theory and who will have to improve his mathematical skills before he goes any deeper. It is hoped that these notes will suggest further directions and possibilities for those already better equipped to handle the job.

Actually, Information Theory is not concerned with meaning as such, at least not in the semantic sense. Its concerns are with the quantity of information contained in a message and not with the semantic content of that information. Its only concern with anything resembling "hidden meaning" is in translating information into codes, like electrical impulses, and decoding them at the other end. However, in its concerns with probability and the predictability of messages, it does seem to suggest an extension of the meaning of meaning.

Information theory began in 1948 with a paper by Clude Shannon of Bell Laboratories. He was concerned with the relation between channel capacities and the reliability of the message transmitted. It had been thought that if you want to be understood, you simply slow down the rate of transmission, as we do when talking to a foreigner with a limited capacity for receiving our language. Shannon, however, discovered that this is not efficient; further reliability is always had by further reduction of the speed of transmission, until zero speed is the next step. He discovered that if the rate is kept fast (though just under channel capacity), but the *redundancy* of the message is increased, a high degree of reliability is obtained. It follows that for communication there must be some measure of predictability about the message being received. A message of zero probability, no matter how slowly it is transmitted, will not be understood.

The amount of information in a message decreases as redundancy increases; there is therefore an inverse proportion between the amount of information in a message and the reliability of transmission, i.e. communication. Paradoxically, information is increased with the degree of randomness the message contains, but this information is about the message itself and has no or little reference to anything else. The ravings of a madman may be random and highly unpredictable, and meaningless. Meaning requires at least two factors, so that given y we may be able to infer or predict something about x.

On the other hand, Wiener wrote, "Just as the amount of information in a system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization; and the one is simply the negative of the other."[3] If information is negative entropy, it would seem to follow that the greater the order, the greater the information. However, if a series in time is so ordered that each ensuing step is entirely predictable then nothing new is discovered and no significant information is to be obtained from the message. In the recent presidential campaign, the candidates' messages were so entirely predictable that, at least by the second repetition, they communicated no information to the listener. This was reflected in the total boredom of the reporters assigned to follow the candidates around. The same message may have information for one receiver and not for another. An attentive listener to a political speech containing already a high degree of redundancy will gain little additional information from reading the speech the next day in the paper; whereas someone who was not there will. However, a slight change in a repeated speech, a new phrase or a new emphasis, will be detected as significant by one who has heard the speech many times, but would be missed by one who is less familiar or entirely unfamiliar with its previous enunciations.

Here is the box we find ourselves in at the moment: both maximum randomness and disorder (entropy) on the one hand and maximum probability and order on the other produce no information. "In fact, it is possible to interpret the information carried by a message as essentially the negative of its entropy, and the negative logarithm of its probability. That is, the more probable the message, the less information it gives."[4]

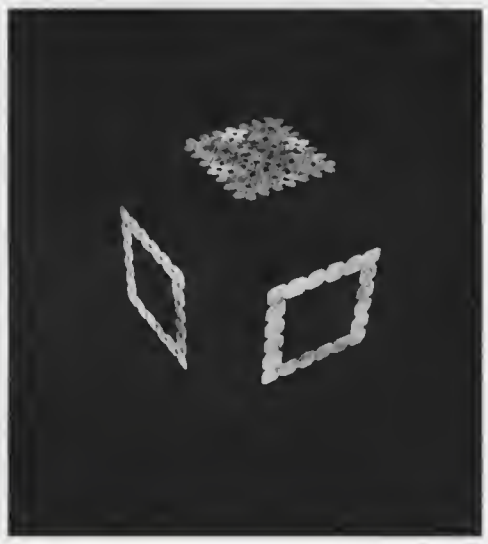
The absence of information in either extreme of complete order or complete disorder seems to parallel the absence of meaning asserted by Husserl in heterogeneous discontinuity on the one hand and the absence of meaning in complete homogeneity asserted by Merleau-Ponty on the other. If information were meaning, an equation could be made, but it isn't. A sentence repeated over and over may still be meaningful, but convey no new information. And yet the strong resemblance suggests that there is some measurable relation between information and meaning. F. J. Crosson has tackled just this problem in his paper, "Information Theory and Phenomenology" and has argued the thesis that there is an inverse relation between information and meaning. Crosson divides information into two kinds: "self-information" and "mutual information". The more random the message the higher the self-information and the lower the mutual information. Meaning, he asserts, is related to mutual information rather than self-information. "As the uncertainty or entropy of the symbols decreases, redundancy increases, and the sequence (or sequences) begins to 'make sense'." Thus, as redundancy increases information decreases and meaning is possible.

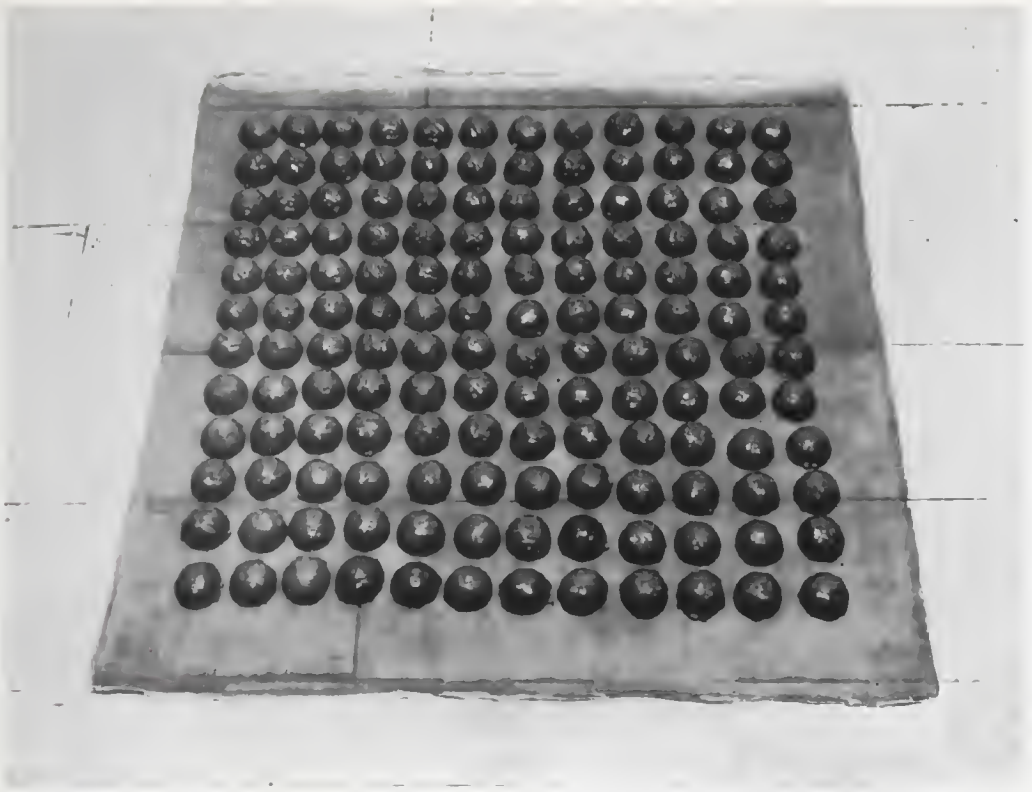
Note, however, that this kind of meaning is not found in a unique thing or object in complete isolation. This kind of meaning obtains only with sets or series or sequences (though the set may or may not be large; it may be only a few items, like the works of an artist this year, or over a period of several years, or it may be the works of all New York artists this season, or it may be the style of a period or civilization).

In any one-man show, whether it be of the artist's most recent works or a retrospective, we are surrounded by redundancy. We have been so conditioned to regard "redundancy with repugnancy" by our English composition instructors that we are little disposed to find redundancy a positive value, but it is. "A clear word of warning is in order that redundancy can be a most beneficial expediency which we ought not to be too quick to abandon for more compact alternatives."[5] In fact, much of the vagueness that surrounds the concept "style" is due to a hesitancy to equate it, or at least relate it, with redundancy.

In earlier articles I have affirmed that the more things remain the same, the more signifi-

Marian Zazeela (visual design) and La Monte Young (sound). *Title to be determined*, 1967–68. Music and light sculpture, with electronic circuitry, ultraviolet light, litho film, painted acetate and plexiglass on wooden base; 18 × 16 × 16″ deep. Private collection, Beverly Hills, California (on lifetime loan from the artists). By courtesy of The Museum of Modern Art





Eva Hesse. *Schema*, 1967–68. Latex sheet 42 × 42″, hemispheres 2½″ diameter. Fischbach Gallery

cant are the slight changes and variations they contain. The meaning of most nonrepresentative, nonreferential abstract art is to be found in these small but significant variations. A constant gallery goer, such as a critic, acquires a high predictive ability concerning what he will see. If he is familiar with the artist's earlier work and also with the general art scene, he will have somewhat clear expectations which are usually fulfilled by the opening of the show. If the show is successful these expectations are satisfied, but not exactly in the way expected. That is, there is an element of surprise and it is precisely this surprise that makes the art meaningful. Usually in retrospect the critic will feel, "Of course he did that and in that way; it was a logical progression from his and/or other artists' previous work." This retrospection may also increase one's satisfaction, both in the work and in oneself for having seen it.

It might make clearer what I am saying to repeat it by applying it. Eva Hesse's current show at Fishbach seems far removed from cybernetic serendipities and motor driven sculptural machines. Her work of the past two years had been involved with circles and hemispheres. Her drawings were of circles arranged in vertical and horizontal rows. Drawing after drawing, row after row, circles, circles, circles. So great was the redundancy of circles in the style of Eva Hesse that one could not think of her without also thinking of circles. Great as this redundancy was, however, no two of her drawings were alike, indeed no two of her circles were alike. Her work also had a high degree of randomness. Such was the predominancy of the circle that one overlooked the other even more constant ingredient of her work: the circles were always arranged on rectangular paper.

Meanwhile (and to simplify), in other peoples' work the cube was undergoing countless transformations and mutations. It was not too much of a surprise that Hesse would try a cube and make it her own with her circles. Her sculpture at the time had largely been made of latex rubber, so in the first cube rubber tubes were woven through round holes in the vertical sides of a cube and cut off evenly inside in such a way as to make the inner walls of the cube planes of circles, very much like the drawings she had been doing, but the outer walls were squares. She then did another cube with plastic tubes in place of the rubber. This material added a new dimension to her work—a play of soft luminosity. These two not entirely new but rather latent aspects of her work—squares and light—captured her imagination and she set off in their pursuit. Now even her drawings as well as her most recent sculpture are squares and rectangles, though their execution retains her distinctive touch.

Of course there is much more to her work than these few obvious things, but what I have mentioned should be enough to illustrate the point that one of the reasons her current show is so successful is that her work satisfies our predictions, but in a surprising and entirely unpredicted way. The meaning of her first cube is not to be found in the cube itself in isolation, but in its relation to her previous and subsequent work, and in its relation to the work of other artists. Because of the high degree of redundancy in her work, the information obtained from one piece to another is generally low and the meaning high. That is, her works communicate with a high degree of reliability.

Perhaps we should place this peculiar meaning of meaning within the context of the general problem of meaning. Panofsky[6] has identified three levels of meaning in the visual arts; arranged from "higher" to "lower" they are: iconological interpretation, iconographical analysis, and pre-iconographical description ("often confused with 'form'"). Each of these three acts of interpretation has its corresponding object of interpretation, equipment for interpretation, and corrective principle of interpretation. The object of the iconological is "intrinsic meaning or content, constituting the world of symbolical values"; the object of the iconographical is "secondary or conventional subject matter, constituting the world of images, stories and allegories"; and the object of the pre-iconographical is "primary or natural subject matter", either factual or expressional, "constituting the world of artistic motifs". The equipment necessary for the pre-iconological is practical experience, "familiarity with object and events"; for iconographical, "knowledge of literary sources (familiarity with specific themes and concepts)"; and for the iconological, "synthetic intuition (familiarity with the essential tendencies of the human mind) conditioned by personal psychology and '*Weltanschauung*'". Finally, the corrective principle of interpretation necessary is a knowledge of the history of tradition. In the case of iconology what is needed is the "history of cultural symptoms or symbols in general (insight into the manner in which, under varying historical conditions, essential tendencies of the human mind were expressed by specific themes and concepts)". For iconography what is required is a knowledge of the "history of types" in which the themes and concepts of these are expressed by objects and events. For pre-iconographical description we need a knowledge of the "history of style", in which the objects and events of the preceding (iconographical) are expressed by forms.

One of the difficulties of adding to Panofsky's neat system is that it is based on a linear mode of thought, in this case an hierarchical one. That which I wish to add fits equally well on either end. What is needed is to bend his linear system into a circle and insert the addition. One of the by-products of cybernetics is nonlinear thinking, which, with a few notable exceptions, has not been much practised in the West except by mystics.

Panofsky began his study of meaning by carefully separating meaning from form. The kind of meaning I wish to add is concerned with form itself. Much contemporary art is without content or subject matter. To many this immediately means that it is also without meaning (though some admit it is not without the possibility of iconological interpretation). By discovering meaning in form I do not intend to equate form and content; I wish to give no weight to either side of the form-content controversy. I simply wish to assert that content has no monopoly on meaning.

To use Panofsky's already existent outline, I would call this additional act of interpretation *the analysis and synthesis* of *message units of code* (encoding and decoding). The corresponding object of interpretation would be *nonrepresentational meaning*. The special equipment for this interpretation would be: *Heuristics* (familiarity of patterns and configurations of elements). The corresponding corrective principle in this new case would be the *History of Language* (insight into the manner in which, under varying historical conditions, *forms* were expressed by the arrangement of elements). It will be noticed that I am equating forms and patterns. It should be added that these forms or patterns are not thought of here as something necessarily static but as also existing in time. In the latter sense such patterns could as well be called messages: "The message is a discrete or continuous sequence of measurable events distributed in time—precisely what is called a time series by the statisticians."[7]

Notes

1. Norbert Wiener, *Cybernetics*, MIT Press, Cambridge, 1948, p.43.
2. *Ibid.*, p.42.
3. *Ibid.*, p.11.
4. Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society*, 1950, p.31.
5. J.L.Massey, "Information, Machines, and Men", in *Philosophy and Cybernetics*, F.J.Crosson and K.M.Sayre, eds., Simon and Schuster, 1967, p.55.
6. Erwin Panofsky, *Meaning in the Visual Arts*, Anchor, Doubleday, Garden City, 1955, p. 26–53.
7. Norbert Wiener, *Cybernetics*, p.8.

Eva Hesse. *Accession III*, 1968. Detail